Shall Biologists Set Up a National Institute?

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THE PUBLIC RELATIONS OF THE biological sciences have been very much neglected, and today these sciences find themselves in much the same plight as did the physical sciences in 1930. The situation of the physicists at that time has been described as follows in a 1942 report of the American Institute of Physics:

The (American) Institute (of Physics) had its origin in the pressing need for cooperation between the several American societies of physics, which need became apparent in 1930 and 1931 and was increasingly realized in the course of discussions held at that time between officers and committees of these societies. There were then operating these trends:

1. A notable and gratifying increase in American research activity calling for an increased number of pages in research journals without adequately increased income becoming available to pay the increased costs entailed. The financial condition of the journals was going from bad to worse.

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2. A growing tendency for physics to "split up."

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No responsible person could contemplate these trends without grave concern. Must the results of research be inadequately reported or be suppressed through lack of funds? Must there be an increasing number of overlapping but unconnected societies for physicists to pay dues to? Would all of the profitable applications of physics appear under some other name, rendering no recognition and no financial support back to the parent science? Did these many groups have no common interests and objectives which they could attain better together than separately?

These words sound strange indeed to one acquainted with the present efficient way in which the American Institute of Physics looks after needs of physics and physicists.

I quote, by permission, from an unpublished paper discussing the present situation of physics:

In 1931 voluntary officers, with a little secretarial help, could handle the needs of the members of the Societies and also speak for them in external matters. Our membership has since tripled. Our Societies are increasingly active. Moreover, the world has awakened to a recognition of the importance of our field of endeavor. Government agencies, national associations in many fields, the public press, educational institutions, industrial organizations, and others now press us for advice, cooperation, and an expression of the point of view of physics.

Most of the problems presented are general, the interests of our Societies in them are identical and the Institute has come to be recognized as the representative agency to turn to. The future development of physics and the personal careers of physicists will be greatly affected for good or ill by what the Institute does. The load which would now have to be borne by the officers of the Societies, if the Institute did not exist, would be far too great for part-time attention. The harm which would result from uncoordinated and internally inconsistent representation of physics would be great.

A specific example may serve to illuminate these generalized statements. It is important to physics to have a single, strong agency controlled only by physicists, to watch, and on occasion to advise concerning, the formulation of laws to govern the control of atomic energy, to extend federal support to research and education in science, and to provide for science in national defense or in world security. Such an agency is, then, needed vitally to watch, and advise concerning the administration of such laws by Government officials and on occasion to assist in their formulations and execution. With such an agency we can discharge our essential duty to society in these respects and, at the same time, ensure the free and vigorous advance of physics and improve the opportunities and facilities open to physicists for valuable and useful work.

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To cite an example, the Institute made a study of shortages in scientific manpower. It introduced the conclusion into a report by Dr. Vannevar Bush to the President on which proposed legislation for a national science foundation was based, used the same conclusions to liberalize deferments and discharges from the armed services, and played the major role in establishing the pre-doctoral fellowships supported by a $550,000 grant from The Rockefeller Foundation. Only an authoritative, fully representative and efficient agency can hope for continuing success in enterprises of such magnitude.

Such examples of course depict only a small part of the present work of the Institute and, taken alone, are insufficient correctly to represent its character.

We can have similar prestige and opportunity in biology if we will.

One of the most significant features of the change in the situation of physics is that the physical societies have been strengthened, and very greatly strengthened, by the activities of the Institute. That is because something new—something which was not attempted before—has been added. The same strengthening of the biological

This and the two following papers were among those presented before a Symposium on Proposed Plans for Union Involving Workers in the Biological Sciences, Section G, AAAS, Boston, December 27, 1946.

societies will occur if these societies get behind their institute as strongly as the physical societies are behind the Institute of Physics.

Lack of Public Appreciation of the Contributions of Biological Science to Victory

Everyone knows the major contributions of physics to victory—radar and the atomic bomb. But how many know that the contributions of biological science were of comparable importance? A physician with whom I recently talked showed great enthusiasm over the medical advances made during the war. When asked to name the most important, he answered: "Penicillin and DDT." Chemists have also claimed both these products as their contributions. I do not need to tell you that both are contributions of biology! In the research on penicillin and DDT, however, the top men controlling policy and appropriations were not biologists. There was not a single entomologist on the Insect Control Committee. True, biologists were called in as "hewers of wood and drawers of water." They had to be, for they alone were competent.

Failure of biologists to receive recognition for their work should be a matter of public concern, for the cost to this Nation of the absence of biological control over biological operations in the war was great. Rather early in the development of penicillin a biologist sought $20,000 to support research on improved strains of the organism. His application was rejected as impractical by OSRD. Later, WPB authorized this research—but only after expending several hundred thousand dollars on efforts in the same direction—and the productiveness of the organism was doubled. Biologists would have known that it was practical and, if in command, not only would have operated economically but would have made penicillin available to the public a year and a half sooner. No man can guess how many lives would have been saved if that project had gone through promptly.

But penicillin and DDT were not the largest contributions of biology to victory. "Food will win the war and write the peace" was a good and true slogan, though clumsily implemented. We could have won the war without penicillin or DDT, but we could have won neither war nor peace without hybrid corn, improved wheats, and other new varieties of crop plants developed by our plant breeders just in time for war needs. Without these improved crops, this country could not have supplied the food to support our armies, maintain our people at home at an efficiency unmatched elsewhere, and provide at the same time the tremendous stores of food sent to a devastated world.

Last year the United States shipped abroad more wheat than was ever before exported by any country in any year. This year's wheat crop again broke all records for production. In fact, each year since 1937 American food production has topped all previous records. This increased yield has resulted largely from improved varieties, the contribution of the plant breeders. But, for lack of proper advertising, there is little public recognition of the critical importance of the part that plant breeding played in our victory.

In the phrase of the physicists, a large proportion of the contributions of biology appears under some other name and neither renders recognition to, nor brings financial support to, the biological sciences. This is solely because the biologists are not organized so that they can do their job as a group. Until they are so organized, they will continue to work for others. *Biological operations need to be directed by biologists* just as surely as medical care must be directed by physicans.

Misuse of Biological Man Power in the War

During the war many strictly biological tasks were assigned to physicians, chemists, and similar personnel, simply because the authorities did not know what biologists could do or where they could be found. At the same time, hundreds of biologists worked under other names than their own. Because the authorities had no comprehension of their own needs from biology, many highly trained men in our fields were assigned low-grade jobs that anyone could have done. This occurred during the same period in which the Services were actively searching for the very men who were being denied the opportunity of using their training in the service of their country.

Bacteriologists in numbers, for example, were being put into the ranks and assigned to kitchen duty at a time when the Army was desperately trying to recruit bacteriologists for special duties—this because there was no national organization able to tell the Army what constituted a bacteriologist and where they could be found and to direct the members of that profession into places where their special skills would be utilized. It is only by such an able, vigilant organization that the Army could be made to see such situations and to provide for its own needs in the way of specialized personnel.

The contrast between the treatment of biologists and that of physicists by the Armed Forces was due to intelligent action by the American Institute of Physics. We need, the country needs, an American Institute of Biology.

When, because of ignorance of the country's real needs, the policies of Selective Service threatened to dissipate the Nation's reserve of scientific men, the National Research Council set up an Office of Scientific Personnel under the direction of M. H. Trytten. This office has been largely responsible for the considerable improvements that have been put into effect in Selective Service and in Civil Service procedures and especially for stopping the drafting of instructors and students in science.

The Office of Scientific Personnel was established through grants from scientific organizations: $3,000 from

the American Institute of Physics; $1,000 from the American Mathematical Association; $3,000 from the Geological Society of America. These grants have since been increased in amount, and the Chemical Society and the Psychological Association now also contribute.

When OSP was set up, I was asked: "Which biological society will contribute the additional $3,000 needed?" How would you have answered that? In the end, the National Academy of Sciences put up the biologists' share.

Need for Professional Organization of Biologists

Biologists are in a position very similar to that of a man drafted in a war. He may take the course of least resistance and remain a private, taking orders from everybody; or he may, by going to some trouble, become an officer and help to direct the course of events.

The biological sciences have been drafted into the national service. We cannot escape that. We may take command, or we may be commanded and do what we are told whether we like it or not. To take command, we must have an effective organization.

The Magnuson Bill seeking to set up a National Science Foundation made no mention of biology or agriculture except as biologists might be requisitioned into the service of medicine. Biologists of every kind were astonished that the public-spirited framers of a national science bill could be so blind to the Nation's need for biological research. Through the efforts of leading biologists, a division of biology was later included. No one should have been surprised that biology was omitted. Biologists have not made the public aware of the importance of biology.

An example of how self-advertising contributes to the public welfare and to the profession concerned is furnished by the recent rise of psychologists into positions of important public service. It is only within our own time that psychologists themselves have had any idea how useful they could be to a complex civilization.

Correct orientation of our civilization in line with the fundamental biology of ourselves and of the plants and animals with which we work is certainly as important to public welfare as are proper psychological services. Clearly, we must have organization, both to serve public needs and to develop our own professions. What kind of organization should this be? How shall we go about its formation?

A group including the presidents of the Union of Biological Societies and the American Biological Society has done much spade work toward promoting the establishment of an Institute of American Biologists. Their views were ably presented by Detlev W. Bronk to enthusiastic audiences last spring at the AAAS meeting in St. Louis and at the annual meeting of the Division of Biology and Agriculture of the National Research Council. Later, a group of 9 representative biologists requested the Division to survey the general problem. The remainder of this paper constitutes a report of such a survey.

Possible Courses of Action

In view of the preparatory work that has been done and the preliminary proposals that have been made for the establishment of an Institute of American Biologists, we face a series of alternatives:

(1) We can agree to set up an institute to serve the combined interests of all the professional people concerned with all of the animal and plant sciences.

(2) We can conclude that the fields of the various biological sciences are too diverse to be covered by any one institute and decide to set up two or more institutes.

(3) We can let this opportunity pass without action.

(4) We can undertake to set up an institute with the support of only a minority of the diverse kinds of biologists. One biological specialty might set up an institute purporting to cover the whole field of biology but really covering only one segment thereof.

For any group to be successful, a minimum budget of $20,000–$25,000 would be necessary. If we assume, as I believe we should, (1) that such organizations should, in the long run, be supported by their members and (2) that $10 per annum is about as much as the rank and file can be expected to pay, it is clear that, for success, groups of at least 2,000 must band together. Groups of 10,000, operating through a centralized administration, would probably be more than five times as strong as groups of 2,000.

The Society of American Foresters and the American Veterinary Medical Association, which alone among our groups have organizations rather closely comparable to the proposed institute, have memberships of approximately 5,000 and 7,500, respectively. The 1944 budget of the former, exclusive of publication costs, was $12,000 and including publication, $31,000; that of the American Veterinary Medical Association, a total of $75,000. The operating budget of the American Institute of Physics in in 1945 was $27,000, and the total was $90,000. This Institute has not, in the past, had individual members. The need of closer contact between the officers and the individual physicists became more and more apparent, and recently action has been taken to add individual members. The membership of its constituent societies totals about 8,000.

Can the Biological Sciences Be Divided Into Two Groups?

Many think that biology is too large a field to be included in one institute. Biology covers more ground and comprises more different kinds of scientists than any other major division of science, but examination of the

biological sciences makes manifest that they cannot be be dichotomously divided. Table 1 indicates an attempted separation of biological societies into two groups. There are, however, important segments of biology, such as cytology, genetics, and bacteriology, that are working great percentage to take out individual memberships.

The balance of the plant sciences is a more compact and unified group than either the animal sciences or those with affiliation to both animal and plant sciences. Problems of considerable magnitude would be encountered,

TABLE 1

Plant science societies		Societies looking toward both plant and animal science		Animal science societies		
Society	No. members*	Society	No. members*	Society	No. members*	Members by groups†
Phytopathological Society	1,130	American Genetic Association	3,530	Economic Entomologists	1,500	2,000
Society of Agronomy	1,200	Society of Biological Chemistry	600	Entomological Society	970	
Horticultural Science	740	Ecological Society	740			
Plant Physiologists	640	Genetics Society	560	Society of Mammalogists	950	
Botanical Society	1,380	Society of Bacteriologists	1,500	Ichthyol. & Herpetologists	570	
Mycological Society	380	Development & Growth	250	Limnological Society	380	2,000
Society of American Foresters	4,550			Wildlife Society	900	
Soil Science Society	500			Animal Ecologists	300	
				Physiological Society	770	
				Society of Biological Chemists	600	
				Pharmacol. & Exp. Therapeutics	280	
				Society for Experimental Pathology	290	3,000
				Institute of Nutrition	250	
				Association of Immunologists	250	
				Society of Zoologists	980	
				Society of Parasitologists	520	
				Dairy Science Association	1,350	
				Society of Animal Production	640	
				Poultry Science Association	540	10,000
				Veterinary Medical Association	7,000	
				Livestock Sanitary Association		
Totals	10,520		7,180			17,000

* Numbers are somewhat out of date and are rounded off.
† Numbers are approximate.

more and more with both plant and animal materials and that cannot be listed under either group. These constitute a third, intermediate group. Let us examine the three groups of biological sciences in detail.

I. *Plant science group.* The plant sciences, over 10,000 strong, are a more homogeneous assemblage than either of the others. Yet there is reason to doubt that they would hang together in supporting a single organization.

The foresters (4,550) are already well organized and possibly would not see the advantage of joining with the other plant sciences in an organization whose objectives would be very similar to their own. There is, however, some reason to hope that they would affiliate with an institute speaking more broadly for all the biological sciences. The basis of this statement is the fact that forestry, standing alone, is somewhat isolated. The officers of the Society of American Foresters are, however, keenly aware of changing conditions that make cooperation of the sciences for public service imperative. An institute of biologists could expect the Society of American Foresters to join, but it would not expect a however, in binding the plant science societies into one unit. As a longtime officer of one of these societies has pointed out, more than one of these groups is essentially dual, comprising at once people whose primary interest is in one of the underlying basic sciences and others whose concern is entirely with practical application.

One might hope that each of the societies would affiliate and that the more scientific members of all of them would join an institute of plant sciences, but few of the more practical people might be expected to come in until the institute had demonstrated its usefulness to them. It would be difficult to guess how many members a plant science institute would lose for this reason, but there is certainly a large enough group of interested people remaining to exceed the 2,000 minimum necessary for such an establishment.

The remaining questions concerning an institute of plant sciences are: Are these groups really ready to proceed now? How shall they proceed? If they should start, are they prepared to follow through and bring their undertaking to a successful issue?

II. *Animal science group.* Aggregation of the animal sciences into a single organization would appear to offer far more of a problem than the accomplishment of such unification in the plant sciences. Some of the sources of disunity among the animal sciences seem to be the following:

(1) The entomologists, perhaps 2,000 strong, are closer to plant pathologists, agronomists, and horticulturists than they are to the Society of American Zoologists. They have rather uniformly chosen to hold their annual meetings in conjunction with the plant science groups.

(2) The field naturalists, another group of nearly 2,000, comprising the mammalogists, the herpetologists, the limnologists, the animal ecologists, and the wildlife specialists, differ widely by training, temperament, and outlook from the experimentalists.

(3) The group of about 3,000 which calls itself the Federation for Experimental Biology, *i.e.* American Physiological Society, American Society of Biological Chemists, American Society for Pharmacology and Experimental Therapeutics, American Society for Experimental Pathology, American Institute of Nutrition, American Association of Immunologists, has a strongly proclinical bent and finds its natural association largely, but by no means exclusively, with medicine. This very natural federation ought to be strengthened and developed beyond the stage of a forum for the presentation of research results, and of a common journal, into a strong national society similar to the engineering societies or to the American Medical Association.

(4) The groups concerned with farm animals, including the Dairy Science Association, the Society for Animal Production, and the Poultry Science Association, have more community of interest with agronomists than with zoologists. These three groups, together with the veterinarians and the U. S. Livestock Sanitary Association, have formed a loose federation of about 10,000 members to promote their common interests.

As to the original parent society of Section F, comparable to the Botanical Society of America in Section G, the Society of American Zoologists has not, in fact, maintained as broad and general a membership as has the Botanical Society, which for many years has successfully staged a "dinner for all botanists."

So far as an outsider can judge by duplicating memberships, etc., the largest fraction of the members of the American Society of Zoologists would probably be more interested in the Federation for Experimental Biology than in any of the other segments of animal science. A smaller number would be associated with the field naturalists, and the smallest fractions would find congenial surroundings among the sciences related to animal industry and entomology.

III. *Intermediate group.* After all the sciences dealing professedly with animal or plant material have been segregated, there remains a very important group of societies with approximately 7,000 members that frankly divides its interest as evenly as possible between animal and plant material. The members of this group, which includes geneticists, cytologists, biological chemists, ecologists, and the Society for the Study of Growth and Development, would be unhappy over the formation of separate institutes of plant and animal science but would welcome one institute binding all biologists together.

The 1,500 bacteriologists, although dealing unquestionably with plant material, would find less community of interest with the Botanical Society of America than with various medical groups or with societies associated with agriculture, such as the dairy scientists and plant pathologists. The microbiologists, among whom bacteriologists form the most numerous faction, are anxious to form a strong organization of their own but have not yet been able to produce a working institute. When they do so, they will greatly strengthen all biology.

It seems evident that separation of biologists into two groups, plant scientists and animal scientists, is not a satisfactory basis for segregating our groups and would not work well in practice.

I feel sure, therefore, that any unbiased study of the problem will lead to the conclusion that proper organization of the biological and agricultural sciences in this country demands the establishment of one over-all institute and half a dozen or more separate national groups concerned with the advancement of the biological sciences. Two of these groups are already organized and operating, namely, the American Veterinary Medical Association and the Society of American Foresters. Steps have been taken to strengthen the organization of entomology and to set up an institute in agronomy and related discipline. I hope these may bear fruit. We need others: one in plant science, pure and applied; one in entomology; one in proclinical experimental biology; one in microbiology; and one in animal production.

Such departmental organizations will, however, never be able to handle the public relations of biology as a whole, and at their best they could never have the necessary influence on public policies affecting biology.

Need for an Over-all Institute to Deal With Common Problems

Although we in the biological sciences are apt to consider ourselves zoologists, botanists, physiologists, bacteriologists, or some other type of specialist, the public with whom we must deal considers biology as *one* science, and whether we like it or not, we must deal with the public on that basis.

At the time we were working to have a division of biology added to the proposed National Science Foundation, some biologists felt that the Foundation would be more effective if two divisions, one in plant science

and another in animal science, were specified. I am sure, however, that those who have studied the long hearings on the bill will agree that it would have been impossible to have obtained the addition of two divisions in the biological field or to have secured recognition for any of the specialties to which we are devoted.

Our experience in allocating National Research Council Fellowships bears significant testimony to the impossibility of segmenting biology satisfactorily. Often, two applicants wish to work on essentially the same problem —one with plant material, the other with animal material. Should one arbitrarily be sent to a department of botany and the other to a department of zoology? In one type of problem, botanists may have made more progress, while in another, zoologists may be further advanced. It is therefore often advantageous to interchange men from one department to the other. A most interesting and important feature is that the proportion of applicants who cannot properly be segregated as botanists or as zoologists has increased markedly in recent years.

The relations of scientists to the public were changed by the war, and the orientation of science must be shifted to meet changed conditions. Briefly, the war brought home to the public, for the first time, the real importance of science. Science began in secret. It had to be kept out of sight of the bigoted leaders of the Middle Ages. The Royal Society of England, for a considerable period, was distinctly an underground organization that met in secret conclaves. With the granting of royal patronage, the classification of scientists in the public mind changed from "dangerous" to "harmless." Now the scientist is recognized for what, in truth, he is—indispensable to national security.

A national science policy is certainly going to be developed. The question before us is: Will the science of this Nation be guided by scientists who understand the needs of science or by laymen who do not? It is essential that scientists themselves organize and delegate some of their number, though it be only a small fraction, to look after the public relations of the scientific professions.

If it be granted that an over-all Institute of Biologists is needed, the practical question is: What shall we do now?

As the result of efforts of the group that sponsored the meeting in St. Louis, a committee widely representative of different kinds of biologists was recently called together to recommend further steps. The committee concluded that there ought to be an over-all institute for all biologists and requested the National Research Council to set up an institute within the Division of Biology and Agriculture. The Council will do anything it can to strengthen its service to biology and biologists. It would, however, be glad to be assured that the request of the committee has the backing of the national societies. The committee's resolution would be strengthened if each of the societies should similarly request the Council to set up such an institute.

The National Research Council is a cooperative association of scientists, as is the American Institute of Physics or the American Chemical Society, and, like them, it is managed and controlled by scientists. It has one great advantage over other scientific associations in that the importance of such an association was seen by the Government, and its formation was requested by an Executive Order of the President of the United States. A large majority of its members are elected by the scientific societies of the Nation. It has two further great advantages not possessed by any other scientific association:

(1) Covering all the fields of science, it can on occasion cross any of the boundaries that sometimes artifically separate scientific disciplines, and it can integrate all science.

(2) Because of its wide experience in administering grants from foundations and the confidence it has thereby inspired in donors of funds, it might be able to finance the new project more readily than could a group of independent biologists.

If it becomes clear that the biological societies and a substantial number of individual biologists will support the Institute, I believe I may say that the Council will attempt to underwrite it.

The most compelling reason for the immediate establishment of one over-all institute of American biologists remains yet to be given. The menace of atomic war is well advertised. It is so terrible that the physicists who know what it means have actively organized to forestall an atomic armament race; and they have gone far toward accomplishing their purpose.

It has been said, however, that if another war should come, it is more likely to be biological than atomic. There is no way to tell how much truth there may be in this statement. Let us hope there will be no war, but, war or no war, preparations for biological warfare are inescapably with us. It is clear that the very possibility of a biological war places an obligation on biologists to develop a considered collective consensus on the subject. That can be done solely by organized discussion such as is possible only through an institute.

A biological war could be far and away more terrible than an atomic war. Progress with the techniques of biological warfare has gone much further than most biologists realize. Although it has been stated that the "biggest research effort in the history of biology" was concerned with biological warfare—defensive as well as offensive—the public, and even the biological fraternity, has heard and thought little of the implication of biological warfare. Gerard Piel (*Life*, November 18, 1946) has stated: "There is as yet no body of responsible opinion on the subject of biological warfare. Formulation of such opinion cannot get under way too soon."

A more authoritative judgment to similar effect has been expressed by George W. Merck in an address at Pittsburgh. Mr. Merck was one of those entrusted, during the late conflict, with the guidance of this country's preparations for and against biological warfare. I quote:

> These investigations and the revelation of their inherent quality of producing not only weapons and defenses, but also fundamental advances of knowledge and practical contributions to medicine and agronomy, have necessitated *the writing of a new chapter in Biological Science.*
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> * * *
>
> Those responsible for our defenses and preparedness in this upset world are alert; they have their programs ready. But they need support—support from scientists, academic and industrial, which should be given generously and in full measure—and it should not wait for an emergency call of patriotism.
>
> There must be support from the people through Congress and its proper committees. That means money for research. If anything is sure about such an investment, it is that it will pay large dividends—dividends for the nation's health and for the country's economy.

Shall biologists have any part to play in the formulation of public policy in biological warfare? We cannot do so as individuals. It must be a matter of group thinking and of group education. Biological warfare involves nearly every branch of plant and animal science: mycology, agronomy, animal husbandry, bacteriology, biochemistry, horticulture, entomology, ecology, mammalogy, veterinary medicine, physiology, both plant and animal. All biology must organize to lead the public in its thinking on biological matters.

Whatever our individual sciences may do to strengthen themselves in public service, it is clear that one over-all organization embracing all the biological sciences is essential *now.*

Research in Fundamental Biology and in Agriculture

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THE TIME IS RIPE FOR RE-EMPHASIS OF the fact that those in the fields of fundamental biology and agriculture derive many benefits from close association, and for calling attention to the opportunity they now have to work together in cooperation and mutual helpfulness to an unprecedented degree in the years immediately ahead. With the enactment by the Federal Government of the Hope-Flannagan measure, permitting appropriations of upwards of $9,500,000 for research in agriculture in 1947, with an increase each year to $61,000,000 in 1951, the way is open for development of a research program of a magnitude hardly yet fully understood or appreciated.

Speaking as one who has been concerned with problems of agriculture, specifically horticulture, I cannot pay enough tribute to the so-called fundamental field of biology for its contribution to the applied field. From the fundamental field comes the new approach, the revolutionary idea, the answer to many a practical problem. Much of the work of the applied field becomes involved in necessary service and in determining that one pound is as effective as two pounds. The basic or fundamental approach provides release from this routine. Added testimony to the contribution of the fundamental approach is the ever-increasing number of men in the applied field who seek training in basic subjects. In fact, in the field of horticulture the trend is to send students into the basic fields for a large part of their training, while maintaining seminars, reading rooms, and discussion groups to provide the horticultural point of view.

The close relation between biology and agriculture is implied in the definitions of the words themselves. Agriculture is "the cultivation of the soil for food products or any other useful or valuable growths of the field or garden," and biology is "the study of living matter." Just what "fundamental" means, as we use the word, is not so clear; I feel that we make altogether too much of it. As with moral codes, so with science: what is fundamental today is no longer so regarded tomorrow. If by fundamental we mean "essential" or "basic," then moisture is fundamental to tree growth, the tree is fundamental to the lumber industry, and lumber is fundamental to the carpenter. Only in the realm of an unsolved problem or an unprovided material does the word "essential" or "fundamental" seem to arise. Any new information is fundamental in the sense that sooner or later it is essential to something else. In fact, new and fundamental information is just as important to agriculture as are the products of agriculture to human welfare. We speak of the race between food supply and population, with famine as a possible outcome. We may as truly speak of the race between fundamental truths and the